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COTTON PROCESS ETHER AND ETHER ANALGESIA

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Only a few years ago, it was customary for the anaesthetists to classify an ether good or bad according to its irritative properties. These were roughly estimated by the annoyance the anaesthetists had from the production of the mucous, and very little attention was paid to the amount of anaesthetic used. If a patient did not respond as rapidly as expected to its administration, he was blamed as being an alcoholic, or to be suffering from an immunity otherwise produced. Some few men still bore in mind the excessive secretions produced by the Clover-inhaler-closed-method and therefore believed that part of the mucous was produced by closing their methods of administration to too great an extent. Still others paid attention to the concentration of the vapour administered, and obtained better results by making this concentration as uniform as possible.

A series of analyses and administrations were undertaken relative to the establishment of a clear line of thought. The irritative impurities were divided into anterior nasal and due to alcohols or acetones; or naso-pharyngeal and due to aldehydes. Smells were for the most part due to the sulphur group.

It was found that in the same methods of administration the irritation to the mucous membrane did not, as first expected, vary with the amount of aldehyde present, but rather with the aldehyde percentage in the ether-vapour, air, mixture, which ether vapour concentration was necessary for maintenance of that patient in a state of anaesthesia. In other words, the actual irritation value of a said ether of standard aldehyde percentage will vary inversely with the anaesthetic power of that ether and directly with the immunity of the patient to ether anaesthesia.

In making these statements we are of course presupposing :

1. Patients do vary.
2. As also do anaesthetic powers of different ether cans.

In proof of the first, a large amount of ether was mixed and administered to different groups of patients. Five cases of a known alcoholic type were compared with five case (of similar weight) of a type which had not indulged. They were 30 to 35 years of age. The alcoholics required from 25% to 75% more ether than did the other variety. The age and weights propositions were considered to already have been sufficiently proved, although the variation is not exact.

In discussion of the second point, variation in anaesthetic powers of cans of ether, we enter upon a field of research which is almost unlimited, and come back again to our startling suggestion of a year ago—"the possibility of absolute ether not being an anaesthetic at all."

ANAESTHESIA

Before proceeding further we had better get down to an agreement concerning the state we are going to understand as anaesthesia. In my mind, anaesthesia may be defined as analgesia (blocking of sensory impulses from the periphery) plus narcosis (or sleep). When a patient shows a type of breathing, a certain amount of muscular relaxation and contracted and central pupils, is he surgically anaesthetized? How often has each one of us seen patients carried to this stage and still suffer from severe shock, and if such is the case, such patients are certainly not anaesthetized—they are narcotized. For years we have recognized anaesthesia, at least ether anaesthesia, by a series of symptons and have neglected this fact.

Interpreting each nervous system by the symptoms which ... arily arise from it, let us consider for a moment exactly what we would obtain if we had a pure nerve poison acting upon the nervous system complex.

1st. It is a well recognized fact that a nerve poison acting on any nervous system, first stimulates, then depresses, then kills.

2nd. The more specialized a nervous system is, the more sensitive it will be, i.e., the more easily it will be stimulated, depressed and killed.

3rd. The order of specialization of the various nervous systems are :

MOST SPECIALIZED.

Special Senses.
Central Nervous System.
Sympathetic Nervous System
Autonomic Nervous System.
Spinal Cord.

LEAST SPECIALIZED.

Are not all these stages and symptoms of nerve cell poisoning simply those of anaesthesia as quoted by text books, and if so, are these typical of anaesthesia proper? I would emphatically say no. They do not in any way fulfil the requirements of our definition, for the blocking of sensory nerve impulses is not taken into consideration, and the very basis of our teaching has, at least, been incorrect. We have been safeguarding the toxicity of ether and have been neglecting the shock of the operation. Nerve cell poisoning it must be remembered, is simply an additive factor to this shock.

ANAESTHIC POWER AND VARIATIONS OCCURING IN SAMPLES OF ETHER

Three years ago statistics affecting 150 abdominal cases of administration of a certain commercial ether were compared with another 150 cases where another make had been given. With the one ether (after induction) 4-8 ozs. were required per hour, and with the other 6-12 ozs. This was the first real record that an ether could vary from another, although by the aldehyde research it had appeared likely. The more powerful ether contained traces of gases as well as more alcohol. Increasing of the alcoholic content was tried in 10 cases with the weaker ether. The alcohol lowered the freezing point of exhaled moisture and prevented mask frosting and therefore retained ether and ether products on the mask longer, but the anaesthetic power was not varied. It was therefore reasonable to believe that there were some other factors besides alcohol that varied the anaesthetic power of an ether.

Research was then undertaken for the obtaining of absolute ether from commercial ethers already on the market. At that time the commercial ethers were in a far more impure state than they are now, as the fusel oil groups were always detectable. After one and one-half years of hard study and work, a product was obtained sufficiently chemically pure to make it desirous to try it on patients. It demonstrated a much milder odor than what we were accustomed to and in fact would have formed the basis for any perfume. On administration, what was our surprise and chagrin to find that it was not a good anaestbetic. A noted anaesthetist, Dr. Samuel Johnston, of Toronto, reported to me that he had used 15 ozs. of it without producing proper anaesthesia. The patient, a man middle-aged, was congested to blueness but no mucous was produced. There was a severe struggling stage with muscular rigidity and sensory reflex persisted and could not be got rid of. After using all on hand, viz 15 ozs. a few drops of Squibbs ether were administered, and the patient sank into a quiet anaesthesia without sensory reflex. Very little more Squibbs was required during the whole of the operation. Exces-

Careful concentration and extraction of gases, etc., from this product showed there to be present certain ethylenes and their by-products. As these were not present in the absolute ether base, they must have developed in the process.

Ethylene gas was then made by text book methods and added to absolute ether. It transformed it into a moderately good anaesthetic, but the results were not to be compared with those already obtained; in fact it was by no means as good as Squibbs. However, with careful synthesizing and research, we were finally able to obtain anaesthetic synergists of an exceedingly high value.

The material, which the medical profession recognizes as Cotton Process Ether, is simply ether purified to almost an absolute stage by the methods originated, plus these synergists. As these synergists were for the most part of a gaseous nature, it was considered suitable to retain them in the ether in greater quantities than would remain at orindary atmospheric pressure. With this end in view, the ether was kept in sealed glass ampules of about 1 oz. capacity, the idea being to administer directly from these.

PECULIARITIES OF COTTON PROCESS ETHER FOR ANAESTHESIA

Although this ether was primarily developed for analgesia only, numbers of men have used it and reported it satisfactory for anaesthesia.

Method 1. Administration from open bottle. Used in open ether bottles (whereby most of its gaseous power would escape) Dr. Samuel Johnston reported a case only a few days ago.

Patient—Female, age 28, weight 160 lbs.
Operation—Intestinal Adhesions.
Induction method—Gas ether, time 4 to 6 minutes.
Time for operation—1 hour.
Amount of ether used—8 ozs. by vol. on open mask.
Condition during operation—Absolute relaxation; no mucous—color and pulse normal.
No after effects.

This method, though apparently successful, should never be used, as ether gases of great value are allowed to escape. By it, the anaesthetic power is about what we have been accustomed to obtain from any good commercial ether, the after effects being possibly less.

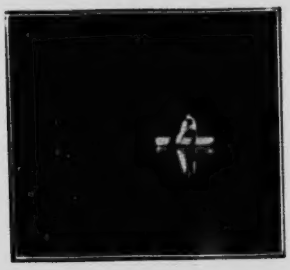


Fig. 1

Fig. 2

Method 2. Administration direct from gas ampule on open mask.

It has been found convenient to use a little device such as shown in Figs. 1 and 2. The glass top is broken off from the ampule and inserted into the rubber socket. Then proceed as with ethyl chloride, the ether gas pressure being sufficient to expel it.

CASE 1—

Subject—Female, age 41, weight, 104 lbs; pulse 120.

Operation—Thyroidectomy.

Previous medication ¼ gr. morpine, 1-200th atropine, 20 minutes before operation.

Administration—Pulse immediately after induction was 110. During the operation it dropped to 100 then to 80. On recovery it registered 106. Time for induction was 3 minutes. Time for operation was 1 hour. Patient recovered sufficiently to speak in 20 minutes. She was, however, a little drowsy for a few hours. Amount of ether used was 5 ozs. There was no after nausea.

Surgeons: Dr. Perfect and Dr. Harrison.

CASE 2—

Subject—Mrs. C., age 70, weight 112 lbs.

Operation—Breast amputation.

Administration—Time of induction 6 minutes. Operation, time 1 hour. Amount of ether used was 5.5 ozs. There was no after nausea and patient recovered before reaching room. Stated that she enjoyed going under.

Surgeons: Dr. Hay and Dr. Wesley.

Method 3—*Oxygen semi-closed.*

(*a*) Guathmeys Apparatus.—As you most likely know consists of three bottles connected together by a common cork tap arrangement; one bottle is used to wash the oxygen; a second contains ether, and the third contains chloroform. Either ether or chloroform can be switched on as required. The administration is controlled by the three-way tap arrangement on top. The ether saturated oxygen is conducted by means of a tube to a closely fitting face mask, to which is attached a re-breathing bag.

The value of this method was first drawn to my attention by Dr. Baldwin, of Columbus, Ohio, who was the first man to use highly charged ether in any moderated series of major cases. He drew to our attention over twenty abdominal operations which had been carried from start to finish with this apparatus. The amount of ether averaged per operation was from one to three ozs. The recovery was more rapid and there was less after nausea than would have occurred with ordinary ether. Concerning the anæsthetic power, when the tinned ether had been used by this method, they always had to use ethyl chloride to induce or they found it difficult to maintain the anaesthesia. Moreover, even with this added factor, about double the amount of ether was found necessary to bring about the same results.

(*b*) OTHER APPARATUS AND MODIFICATIONS. The first thought of is similar to the diagram on opposite page described below :

(*c*) Ether Ampule.

(*d*) Soft rubber bag through which oxygen feeds at the rate of about 10 litres per hour.

(*e*) Ether container.

(*f*) Tube to mask of patient.

METHOD OF OPERATING :

Mask is fitted tightly over face of patient. Ether is placed in "e" and tap "a" is opened. Tap "b" is then slowly opened. As more ether is required tap "a" is closed down. Excess re-breathing causing dypsonia may be rectified by emptying "d." The whole apparatus is hung on the large oxygen tank.

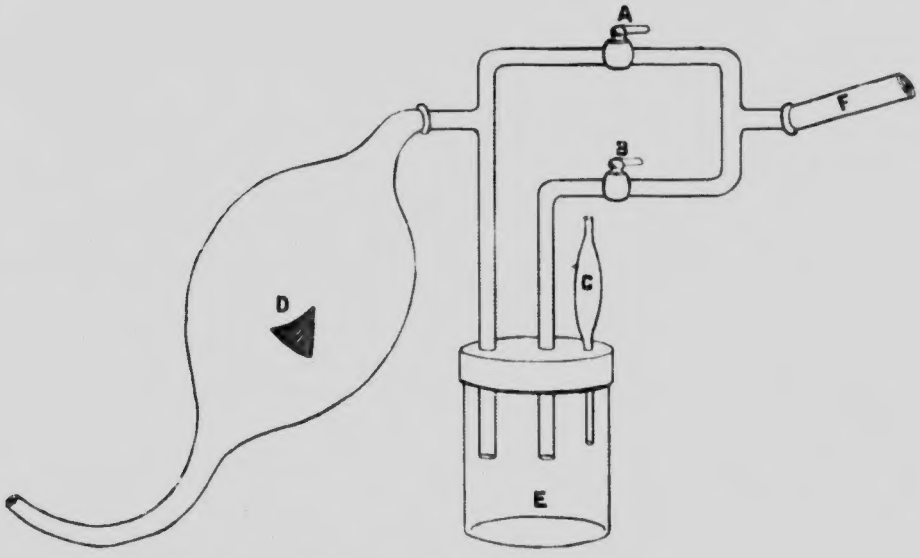
This method is positively fool proof for our ether and will maintain patients uniformly at any depth of anaesthesia. With it the ether shows over double the anaesthetic value of tinned ether and the recovery is instantaneous. It has the advantage over Guathmeys'

Apparatus, in that the ether in this is evaporated and no particles are carried over, as they are bound to be when the oxygen is passed through the ether.

THE SECOND APPARATUS :

An effort was made to make the principles of our first attempt and at the same time make it less clumsy to carry around. It is described under analgesia and suggestions for war administration, page 235.

1. Subject—Nurse, age, 28, weight 125 lbs.
   Operation—Removal of Tonsils.
   Administration—By Dr. Cotton's special apparatus. Time for induction 4 minutes. Complete surgical anaesthesia apparently obtained. Ether was stopped and one tonsil was removed. Time for removal was 2 minutes. She was then completely awake but still without feeling. She carried on active conversation for 3 minutes when the mask was again replaced. Re-induction time was 1 minute. The same rapid recovery came about after the removal of the second tonsil. Soreness in the throat was not detectable for over one half hour, and during this period she was able to take nourishment. She considered the whole procedure a very pleasant experience. The amount of ether given was 1.5 ozs. Throat reflex was present before each tonsil was completely removed.
   Surgeon : Dr. Perfect.
   Witnesses : Dr. H. Harrison, Dr. Carveth.
   Ether : Standard.



2. Subject—Mrs. B., age 35, weight 115 lbs.
   Operation—Removal of 14 teeth.
   Administration—By Dr. Cotton's special apparatus. Patient, sitting posture. Time for induction 4 minutes. Patient held her own mouth open. She did not complain of pain for 10 minutes. She was re-induced in two minutes. The remainder of her teeth were then removed. She was quite awake all the time and was capable of walking afterwards. Amount of ether used was 1.5 ozs

Surgeon—Dentist.
Witnesses—Dr. Carveth, Dr. Perfect, Dr. Harrison.
Ether—Standard.

REPORT FROM MRS. B.—

"Arrived home about 1.30 a.m. feeling pretty good considering, so much so that I walked home rather than get in and out of a street car. Had a cup of tea and soaked biscuit and laid down. When taking the ether I did not have any going away sort of feelings and was not at all nauseated. I can remember coming round partly before the dentist finished, but it caused me no pain. I could have eaten hot roast pork had there been any and my mouth permitted."

(Signed) LILLIE B.

3. Subject—Female, age 35, weight 115 lbs.
Operation—Cholecystectomy and appendectomy.
Administration—By Dr. Cotton's special apparatus. Time for induction 5 minutes. Previous pulse, 100. Pulse during operation, 70. Relaxation during first part of operation was easily obtained. Duration of operation 1 hour and 20 minutes. Amount of ether used was 3.5 ozs. Regurgitated 4 ozs. but did not remember it or suffer from any after nausea. She was able to talk while being returned from the operating room.
Surgeons—Drs. Perfect and Harrison.

Besides these reports a number of opinions of interest and value have been given concerning Cotton Process Ether Anaesthesia. The Carveths, of Toronto believe it to be ideal as an induction anaesthetic, for it is very rapid and out of a fair number of cases they have not yet noted any excitement stage. They like continuing it by any method whatever on anything but abdominal work. Here, they state, that the patients' muscles cannot always be completely relaxed, although there is never any muscular spasm. This opinion has been corroborated by some other anaesthetists and therefore deserves consideration.

I myself have found that by open methods, although the amount required is not large, recovery is so rapid from deep stages of sleep that careful watch and even drop rate administration is required. By oxygen semi-closed apparatus the maintenance is much more regular. But, however, if it is badly administered a certain amount of salivation results.

POST-OPERATIVE NAUSEA

Relative to the anaesthetic post-operative nausea has from a practical standpoint been recognized for years as the great disadvantage of ether administration. In a previous paper it was shown that Carbon-monoxide was produced by superheating of ether in contact with a metal and the slighest trace of this poison when present in ether will produce severe nausea. It is frequently introduced into ether by the high temperature from soldering the can. It was also mentioned "that if a certain ether was not a sufficiently powerful anaesthetic due to the absence of its synergists, a very large amount of the ether or narcotic group will have to be administered and post narcotic sickness must follow."

With our ether, nausea after the patient was awake, has not yet occurred as far as I know, but regurgitation before waking has frequently taken place in oxygen semi-closed methods when the ether was stopped too suddenly. However, in choosing our patients for this anaesthetic, attention was always paid to the urine analyses in order to detect whether there was present any degree of acidosis. In judging the sickening effect of any anaesthetic it is also well to bear in mind the following two facts :

1. Post-operative nausea rarely occurs in old people especially when they are suffering from any degree of blood pressure.

2. A certain class of operations having to do with the intestines, especially the gall bladder, will of themselves give rise to nausea.

ANALGESIA

We now en[illegible] upon the study and review of facts for which this whole research was undertaken- [illegible] reli[illegible]ble production of Analgesia.

EXHIBIT "A"

COMPARISON OF INDUCTION AN[illegible]GESIA WITH ABSOLUTE AND ETHYLENE ETHERS.
Method-Oxygen Semi-closed.

Absolute ether was first administered to 12 cases and the results studied relative to blood pressure, pulse, analgesia, and after results. Two days later a similar series of administrations were undertaken on the same cases, only this time the absolute ether contained a large amount of ethylene derivatives.

With the absolute ether the blood pressure rose immediately 16 to 20 points (systolic), whereas, when ethylene was present, in half it dropped 10 points, in three it remained normal, and in the remainder it [illegible]se 10 points.

Concerning analgesia, we obtained [illegible] six cases with absolute ether, while the other six became hypersensitive, and continued [illegible]do so until they fell asleep. The cases to which the ethylene had been administered all had their analgesia period long before becoming unconscious.

In all cases to [illegible]ich the a[illegible]olute ether had been given, a violent headache developed within one hour of [illegible] administration. They complained of a very depressing sensation during the induction and most of them went into a struggling stage, at which point the anaesthetic was stopped. Their recovery was exceedingly slow. Those cases receiving the ethylene ethers did not complain of after symtoms. Their recovery was instantaneous and they enjoyed going under. No one of them showed the slightest inclination to restlessness on induction.

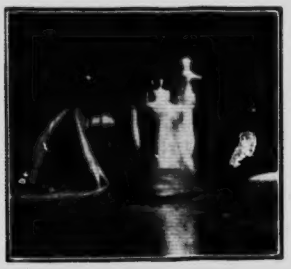


FIG. A

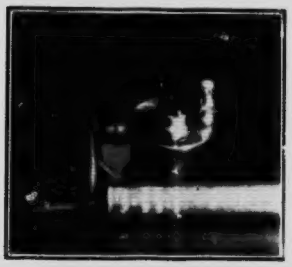


FIG. B

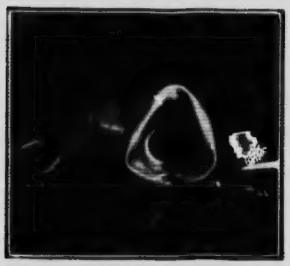


FIG. C

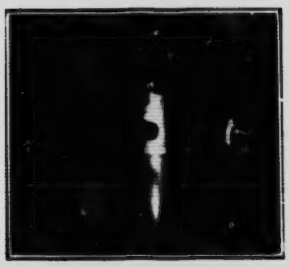


FIG. D

Figures A, B, C, D, illustrating Cotton apparatus.

EXHIBIT "B." REBREATHING OF OXYGEN

As methods including the rebreathing of oxygen had been found useful for the administration of this ether, it was thought desirable to study them more closely. Apparatus similar that that described under Anaesthesia, page 226, was used. The ether containing bottle was filled with caustic potash sticks in order to absorb any carbon-dioxide which would accumulate. An excess of oxygen was administered i.e., 10 to 20 litres per hour, and the blood pressure was followed repeatedly in twenty cases. Eighteen of these showed a small drop in systolic and a fair rise in diastolic pressure. The other two had their rise in diastolic, but their systolic did not vary. The pulse remained normal in each case.

EXHIBIT "C." BLOOD PRESSURE VARIATIONS

The following figures are the average of those recorded in a large number of administrations by an open mask method :

A COMMERCIAL ETHER CONTAINING VERY LITTLE ETHYLENE

Time	Systolic Pressure	Diastolic Pressure	Pulse Pressure	Pulse	
	120	80	40	85	
1	150	70	80	116	
2	160	72	88	96	
3	160	90	70	80	Beginning analgesia.
4	130	100	30	80	Not Surgical.
5	135	110	25	80	
5.5	145	118	27	80	
6	150	118	32	80	
6.5	140	90	50	80	
7	130	85	45	90	No Analgesia.
7.5	128	90	38	100.	
8	120	85	35	110.	
8.5	118	100	18	100	
9	115	105	10	90	Struggling Stage.
9.5	110	85	35	90.	

AN ETHYLENE SATURATED ETHER

Time	Systolic Pressure	Diastolic Pressure	Pulse Pressure	Pulse	
	120	75	40	80	
1	130	90	40	90	
1.5	140	100	40	100	
2	140	105	35	80	Analgesia to surgical degree.
3	140	100	40	80	
4	120	70	30	72	Sleep.
80 mins.	120	70	30	72	Anaesthetic stopped.
85 "	130	90	40	85	

From the above curves it is easily recognized that the ethylene group acts as a stapiizer of the circulation. A peculiar point relative to the struggling stage is that it always seemed to occur when the pulse pressure was extemely reduced by a dropping of systolic as well as a rise in diastolic blood pressure. At this time when the patient was sufficiently conscious, she always blamed her restlessness to a peculiar numbness (not analgesia) as well as a hollow sensation in the abdomen.

At the sleep point there always occurred a drop of about an equal amount in both systolic and diastolic pressure. Whether or not this drop is responsible for sleep is a question which can only be satisfied by circumstantional evidence.

THEORY OF ANALGESIA

With the present data on hand, viz., Exhibits "A," "B" and "C" let us study the various physical chemical changes of state of solution and vapor tension of ether as it passes through the blood stream with the end in view to find out how its synergists may act in order to allow analgesia.

The boiling point of absolute ether, as we all know, is about 34. 5C. When ether is administered, it passes through the walls of the alveoli to enter into solution in the blood circulation, in the lung tissues. The temperature of this blood is between 36 and 37 C., i.e., 1.5-2 5C above the boiling point of ether. On this account, an ether gas tension will develop thereby limiting the amount of ether which can enter the blood stream.

The point of maximum heat production (in the circulation) is in the end capillaries of the peripheral tissues where combustion takes place. The temperature here suddenly rises to over 38 C. It will therefore be easily understood that when the ether from the lung tissue reaches this point through the arteries, the gas tension will be enormously increased, both on account of lowering of pressure and the increasing of the temperature.

Ether, like alcohol, acts centrally and otherwise on the nervous system to cause a general vaso-dilatation thereby slowing the stream in the capillaries and reducing the metabolism and temperature. This is exemplified by our diastolic pressure reduction taking place on administration of absolute ether.

Volatile anaesthetic substances enter the blood stream at the lung capillaries much more slowly than does ether. If they are present in the ether administered, the vaso-dilatation caused by the ether will be replaced by vaso-constriction as soon as they gather in the peripheral circulation in sufficient concentration. That is, when we administer an ether together with these anaesthetic gases, we will have a short period of vaso-dilatation followed by vaso-constriction, and increased capillary combustion. During this vaso-dilatation, the heart will beat more rapidly due to the relief of pressure, but as soon as vaso-constriction begins to occur, the pulse slows with the increasing resistance.

I have already mentioned the fact that when ether only is present in the blood stream, there is an ether gas tension increase in the peripheral tissues which is lessened according to the resulting vaso-dilatation, by the reduction in metabolism as well as the relative approximation of blood pressure between arteries and capillaries. It can thus be seen that when the ether gas tension in the capillaries becomes very great, as it would in the above case, and these capillaries are constricted, there will be an enormous escape, and retention of ether into the surrounding tissue fluids, and the ether becomes concentrated in the lymph and tissue cells. When this concentration is sufficient the sensory nerve endings lying in the tissue fluid will become insulated, and no longer able to function. The motor nerve endings are not affected as they enter directly into the cells that they govern.

In the central nervous system, where the matabolism is not nearly so great, the ether will not localize. In other words, if the capillaries throughout the body are kept mormally constricted, ether will localize in tissues according to their metabolism rate state and this localization produces localized analgesia by sensory nerve ending insulation.

Our blood pressure curves show that ethylene and carbon-dioxide, as we have already assumed, tend to equalize the circulation by lowering of systolic as well as raising of diastolic

pressure. Oxygen, as we have proved, does to a much less extent practically the same thing, and, therefore, might be classified as a synergistic gas.

It is well to remember that volatile anaesthetic substances cannot maintain constriction of capillaries unless the nerve control to these capilleries is healthy; and without this maintenance marked analgesia is impossible. Bearing upon this point is the fact that it is exceedingly difficult to obtain analgesia (without narcosis) in people suffering from anaemia, hemmorrhage, syphilis or prolonged fever.

METHODS FOR OBTAINING ANALGESIA WITH GAS ETHER

These aim to utilize all the gases in the ether, as the analgesia power of an ether depends upon their presence.

(*a*) Open Mask Administration Direct From Ampule.

An arrangement such as described under Method 2 in Anaesthesia was found convenient.

Case 1—

Female—Weight 180 lbs, age 42.

Operation—Breast amputation.

Time of Operation—15 minutes.

Anaesthetist—Dr. Carveth.

Patient capable of talking throughout whole of operation. She did not have any pain whatever, and in fact could not feel on what part of the body the Surgeons were working. Ether 5 ozs.

Case 2—

Male—Base Hospital, Toronto, weight 150 lbs, age 48.

Operation—Resection and Cauterization of part of abdomen for Cancer.

Time of Operation—1 hour.

Patient capable of talking throughout and quite clear mentally. He had no pain whatever. Pulse ranged from 72 to 80. He complained of being hungry before the hour was up. Pain returned within three minutes of cessation of anaesthetic. Ether used, 3 ozs.

Case 3—

Male—Weight 180 lbs, age 18.

Operation—Adhesions and resection of tubercular mass from abdomen.

Time of Operation—1 hour and 10 minutes.

Patient remained very clear mentally and cracked jokes throughout. He was given a small meal while the surgeons were operating on him. Abdomen was completely relaxed, except at one time when he insisted upon kissing the nurse Eyes were slightly dilated and pulse remained at 80. Amount of ether used, 3 ozs.

Case 4—

Male—Age 48, weight 132 lbs.

Operation—Opening and scraping abscess.

Time for induction 5 minutes. Senses dulled and unable to talk clearly. Length of operation 12 minutes. Amount administered 2 ozs. Held his breath for one half minute during recovery. Recovery absolutely complete within one minute. He then immediately changed tables himself. There were no after effects.

Surgeon—Dr. Harrison.

Witness—Dr. Carveth.

CASE 5—

Male—Age 35, weight 190 lbs. (Returned Soldier).

Operation—Opening Arm.

Patient complained of feeling dull, but otherwise felt normal. Time of operation 15 minutes. Time to induction to analgesia, 6 minutes. While under he stated he did not want to simply lose pain, but that he also wished to go to sleep, as he was tired. Amount of ether used, $3\frac{1}{2}$ ozs. At two previous operations it was impossible to induce him with commercial ethers, and chloroform had to be resorted to.

CASE 6—

Male—Age 42, weight 140 lbs.

Operation—Resection of teeth from ankylosed jaw.

Time to induction—4 minutes.

Time of Operation—1 hour and 40 minutes.

Amount of ether used—6 oz.

He sat up and held head in position while teeth were resected from jaw. He did not have any sensation whatever. He answered phone twice during the operation and seemed be in possession of all his mentality.

CASE 7—

COMPARISON OF COTTON PROCESS ETHER WITH ORDINARY C & E MIXTURE

An opportunity was lately given me to witness a comparison between ethylene ether and C. & E. The patient was aged 24, and on account of having had a recent attack of pneumonia, it was considered advisable to do her operation under local anaesthetic. She was suffering from an acute appendiceal condition.

She was given $\frac{1}{4}$ morphine and 1/200 atropine at first as she was exceedingly nervous. At 11 p.m. she entered operating room and the skin was carefully injected with 1/10% anocain solution. Six minutes later the incision was made, but the patient was unable to stand it on account of the deep soreness of the underlying abscess. At the request of the surgeon the house surgeon started C. & E. administration. The patient became excited but sensation was not reduced, after $1\frac{1}{2}$ ozs, she dropped into a light sleep, but the abdominal muscles were extremely rigid and there was a tendency to stop breathing. Incision made through anterior aponeurosis was followed by severe muscle spasm. I then suggested that they use an Ampule of my ether on the open mask. The patient was allowed to wake up and my ether was given on an open mask without the usual surrounding towel. Within four respirations her muscles were completely relaxed and she was entirely without sensation, although able to answer questions clearly. She was not excited and would do anything which she was told. The operation continued and the abdomen was opened. Appendix had not ruptured, but whole of caecum was fixed by adhesions to abdominal wall and pelvis. 1 oz. of ether had been used by this time and they had to send to the store room for more. Meanwhile chloroform and ether were again used in order to see if it had the same effect.

The results, however, were quite unsuccessful, as sensation returned and if patient were put to sleep with it she became blue. Ethylene ether was again given. She woke up and was able to talk. Her abdomen again relaxed. Operation continued for one hour. Adhesions were broken down and appendix successfully removed. 3 ozs. in all of our ether were used. Patient at any time during operation, while ethylene ether was in use, could have walked as easily as she talked. On questioning her afterwards she remembered answering questions but did not know anything about the operation while under the ethylene ether.

One peculiar fact was noted that while under ethylene ether the pulse ranged about 80 and when the C. & E. was given it would immediately rise to 120. The patient stated that she was hungry and thirsty during the operation as she also was afterwards. There was slight dilatation of pupils but otherwise they were normal. They would roam about when covered, but fixed on any object when allowed to see.

She was as clear mentally at the finish of the operation as she had been before. Pain started within 3 minutes of cessation of anaesthetic. The anaesthetic was administered throughout by a house-man under my direction. Pulse, as I have previously noted, was remarkably slowed at point of analgesia.

Other Cases—

15 Obstetricals—

These patients were entirely relieved from pain but the expulsive effort was not reduced. Six were primaparis and in four forceps had to be resorted to. One was an induced delivery of a dead foetus at eight months, while with another, operative measurse had to be undertaken on account of hydrocephalus.

59 cases reported by Dr. Hudson of successful analgesia.

8 Dentals reported by Dr. Carveth.

32 Dentals Toronto General Hospital Dental Department.

6 Dentals relief of pain for drilling.

6 Breast abscesses.

10 Dressing administrations.

1 Epispadius.

2 Herniae.

1 Varicoceles.

1 Abdominals.

(*b*) Bottle Inhaler Method.

Two varieties of this apparatus have been perfected. The apparatus constitutes in each case a small bottle capable of holding at least 1 oz. The cork of the simpler form was perforated by two tubes, one of which opened to the air and the other T'd off to nasal tubes coming from nose of patient. Ether was introduced through open tube to bottle and patient breathed in through nose and out through mouth as he required ether. Valves were later introduced to patient breathing back over ether in bottle.

In the more complicated variety the same principles were accomplished by a single perforation of bottle cork by means of sleeve tubes connected with the valve.

This method of administration was found quite unsatisfactory in a number of cases as it was difficult to teach the patients how to breathe, and they would constantly forget as their memory became undermined by the ether. It was used successfully in over a hundred dressing cases and twenty obstetricals. In the latter variety there have, however, been a number of failures reported by this method.

WAR ADMINISTRATION

Open mask administration would be out of the question, as the cases are difficult to induce and moreover every particle of ether on the battlefield should be made count. With this end in view, the inhaler bottles described under "Home Administration" were first thought suitable. Dr. Foot, a brillaint chemist who is now serving, attended to the origination of the details of these bottles. They, however, proved unsuitable as time had to be consumed in each case in order to teach the patients to breathe properly.

I then made a mask which appears to be satisfactory. With it, analgesia results after four breaths have been taken, and the patient is only depended upon to hold the mask over the face.

The photographs on page 229 are, for most part, self explanatory. Figs. A & B view the mask from the side, while C shows the face part. Fig. D represents the shutter by which the ether is turned off and on. Ether is turned off when handle on shutter points towards nasal end. The patient then will breathe directly into the bag. In order to turn the ether on, the shutter is rotated towards Intake Tap. Ether can be either poured in by unscrewing the tap or an aliquot can be introduced from ampule when it is inserted.

To use the mask for prolonged work oxygen had to be run into the bag, at the rate of 6-12 litres per hour. If the accumulation of carbon-dioxide became excessive in the bag, that is, the patient's breathing became stertorous, the bag was emptied of its gases and the patient was allowed to take a few breaths of air. For short work, oxygen is not necessary as the patient is ordered to blow a big breath of air through the mask into the bag before starting.

One case lately demonstrated at the Western Hospital had been knocked down by a motor car and the clavicle fractured. She did not want an anaesthetic on account of prejudice, but when told she could give it to herself she was more satisfied. The patient talked during the whole operation and was entirely without pain until six minutes after the anaesthetic was stopped. She then stated she wanted more of it as it made her happy. There were of course no after effects. Major Harrison of the British Army, was in charge. A second case was undertaken with this same apparatus. The patient was 70 years of age and weighed 110 lbs. Operation was to open knee joint. He required 2½ minutes to induce to analgesia. The time of operation was over 12 minutes. About one ounce of ether was used and the patient was not at any time abnormal mentally.

For ordinary dressing cases or probing of wounds, only one to two c's of ether are required when the mask is used. As many as twelve dressing analgesias have been induced with one ounce.

Re War Administration. One very important point on the battlefield is that of cigarette inhalation immediately previous to anaesthesia by any ether. If the subject has inhaled cigarette smoke within ten minutes of his induction, the systolic blood pressure will rise from 30 to 100 points beyond that which would normally take place, and even heart dilatation may result. He will always suffer from a headache afterwards. Cigarette inhalation following an anaesthetic always aids their recovery from it.

Many men have complained to me that in order to use this gas ether they had to learn new and complicated methods of administration, and they did not seem to recognize that this knowledge simply allows them to understand the materials they thought they were so familiar with. In fact, the statement only goes to emphasize that anaesthesia is a specialty requiring the highest possible education in both chemistry and physiology. Unfortunately, certain members of our profession, due most likely to their lack of interest in the subject, have adopted the layman's view that an anaesthetist is a mechanical technition who pours a certain dose of anaesthetic down the neck of his patient. It is quite true that a number in their pecuniary endeavor certainly may be no better, and the place of these few might with profit be replaced by a nurse, or even a trained orderly, and such could certainly not be called anaesthetists; they are at best assistants to the surgeons. If this view is persisted in it will not only endanger human life but further progress in anaesthesia will be completely blocked and a blissfull ignorance will reign.

A number of nurses who have witnessed analgesia work with this ether for dressing cases have been delighted, inasmuch as they considered the thing so simple that it represented the

beginning of the reign of nursing anaesthesia. For light analgesia such as required in the dressing of fresh wounds on the battlefield, they are no doubt correct, but for major operative surgery, a great deal more knowledge is required for its use than has been heretofore necessary. This whole research was persisted in for the sole reason of obtaining a dressing ether, and if it can be utilized efficiently to make things more bearable for the boys at the front, our purpose will have been completely accomplished. The theoretical and operative work mentioned in this paper were simply undertaken to this end and are given to the medical profession for what they are worth.

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